LETTERS TO THE EDITOR.

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Kew Publications.

As I was responsible before I left Kew for the publications noticed in NATURE of June 21 (p. 180), perhaps I may be permitted a few words of explanation.

The Kew Bulletin was not intended at the outset to rank with scientific journals. It was started at the desire of Parliament for the purpose of issuing, for public use, information for which there happened to be a demand, and of a commercial, or at any rate economic, kind. It was subsequently decided by the Government that it should be the vehicle for other matter, scientific or otherwise, for which prompt publication seemed desirable.

It is sent out to all the botanic and agricultural departments in correspondence with Kew in India and the colonies, and much of its contents is usually reprinted in the local journals.

It also serves the purpose of expeditiously answering inquiries at home. A stock of the numbers is kept at Kew for communication to correspondents. So useful has it proved in this way that it has been necessary to reprint more than once a large number of the articles. The output in any one year may have been exiguous; but if there was no urgent demand for information on some new subjects, there was usually more pressing work on hand than the mere manufacture of padding. As, however, the Bulletin is filed in many libraries, I was glad to have the leisure to put the successive annual volumes into a shipshape form. When the next general index is issued the whole series of volumes will form a sort of rough, though necessarily incomplete, encyclopædia of practical information on Indian and colonial agriculture and products.

The announcement of appointments may have been belated, but that again is of little consequence, as they are only intended to be items in a continuous record.

The catalogue of portraits was not supposed to be exhaustive, and does not compare, therefore, with the "Catalogus Stockholmiensis." It is simply a hand-list for the use of visitors of the portraits exhibited in Museum No. 1. The Kew collection has always been popular, and, as I know of no other, *is* "probably unique," but it has latterly grown out of all bounds. As the available space was restricted, I made a selection, and, so far as prints were concerned, had them uniformly framed. I was guided by considerations which I have stated in the preface, and I confess I was largely influenced for the purpose of public exhibition by artistic merit. Mere trivial photographs and cuttings from illustrated papers, though valuable so far as they go, seem to me most conveniently preserved in portfolios.

The personality of those who have made a mark in scientific history has, I think, a peculiar, because intimate, interest. The world is certainly the poorer for having no portrait of Gilbert White. Only recently I have seen the posthumous portraits of two distinguished men of whom no memorial now remains which bears the impress of vitality.

In the seventeenth and eighteenth centuries few men of any note disdained to transmit their portraiture to posterity by the aid of the engraver. It was not, indeed, until the middle of the last century that the practice expired in the more feeble art of the lithographer. Some examples of its decadence I felt obliged to withdraw as painful caricatures. Nowadays, modesty or indifference seems to leave neglected all but the most eminent. I am not without hopes that more space may be found at Kew for portraits. I hope the collection may continue, as in the past, to be the recipient of gifts from private liberality, and that in this way many obvious gaps may be filled up.

W. T. THISELTON-DYER.

Witcombe, Gloucester, June 25.

A Remarkable Lightning Discharge.

THE afternoon of Saturday last, June 23, was sultry, and it was therefore without surprise that about 8.30 p.m. we observed the reflection in the clouds of lightning to the west and south-west, and heard from time to time the low sounds of distant thunder; there was no indication of the storm coming near to us until 9.30 p.m., when we were startled by a tremendous explosion and a brilliant flash of light, which, according to some observers, was continued after the explosion took place. This explosion was, I think, the loudest that I ever heard, and the impression on all of us was that it was quite close, and I am told that it was heard nearly two miles off as if it was close at hand. The thunderstorm continued for some hours after this explosion, but never came near to us.

It was not until the next morning that we discovered the scene of the explosion of the fire-ball, if such was the nature of the agent.

In one part of the garden here there is a mound—the remains of an old greenhouse—of irregular form and height—on the northern side grown over with ferns, ivy, and weeds, from which, towards its western end, grows an ash tree of moderate size, which gives out its first branches between 16 feet and 17 feet from the ground. The leaves of the tree seem intact, but the ivy of the trunk, from immediately below the branches down to the mound, has been more or less stripped of its leaves; a space half round the tree has been disturbed, and the weeds and plants thrown down, very much as if they had been trampled down by human feet; and this disturbance is continued in a line down the mound on the northern side, the plants being depressed from above downwards, and the gravel path at the foot of the mound broken up more than half-way across. Many of the leaves of the ivy have been scattered about, and many of the leaves lying on the mound have been torn to pieces. Several pieces of dead wood on the mound have been broken asunder. A branch of ivy close to the root of the ash tree has been stripped of its bark; an old brick lying on the mound under the vegetation was broken into four pieces, two small pieces and two large of nearly equal size; one of these larger pieces was found on the mound, one was found about 7 feet 6 inches from the point at the foot of the mound where the disturbance was seen, one smaller piece was about 7 feet beyond this, and another yet 2 feet further beyond the last. A piece of highly-crystallised Old Red Sandstone lying on the mound was found with a new and unweathered exposure several inches in length, and fragments of the same stone with new faces were lying near.

The conclusion from these facts seems to me to be that the electric agent, whether a fire-ball or not, must have approached the ash tree in a nearly horizontal line and struck it just below the lowest branches, have passed down the tree to the mound, have disturbed the vegetation to the south of the trunk of the tree, have passed then towards the north down the mound, and then to have nearly crossed the garden path, when it disappeared. When exactly the explosion took place I feel at a loss to ascertain, but perhaps some of your readers may be able to assist in determining this point. EDW. FRY.

Failand, near Bristol, June 25.

The Magnetic Inertia of a Charged Sphere in a Field of Electric Force.

DR. O. HEAVISIDE has investigated (NATURE, April 19) the slow motion of a charged conducting sphere through a uniform electric field, in a direction *parallel* to the electric force of the field, and has calculated the increase in the magnetic energy and inertia of the sphere resulting from the re-distribution of the charge under the influence of the field. His paper has suggested the following investigation, in which the slow motion of the sphere is *at right angles to* the direction of the electric field. But, as Dr. Heaviside has pointed out to me, this problem has no single definite solution. For, if the sphere, initially at rest in the field, be set in motion, the motion of the unequally distributed charges on the surface of the sphere will tend to give rise to magnetic force in the interior; but the magnetic force will only gradually pene-

trate into the interior, and electric curents circulating in the sphere in parallel planes will cause a magnetic force opposed to that due to the moving charges. If the conductivity be perfect, these currents will persist, and the interior of the sphere will be permanently free from either electric or magnetic force; but, with finite conductivity, the currents will die away, and the magnetic force will finally attain a definite value inside the sphere, although the electric force vanishes. In each of these cases a solution is easily found; but while the currents are dying away the magnetic energy gradually changes, and the calculation of the energy at any given time might be difficult. I therefore confine myself to the two limiting cases. The case of the final stage when there is finite conductivity I had solved when Dr. Heaviside suggested to me that I should include the case of infinite conductivity in my investigation. The present communication is the outcome of that suggestion.

The sphere is of radius a, and carries a charge Q at a speed u, which is very small compared with v, the velocity of light; the strength of the field is F, and the specific inductive capacity is c. I employ Dr. Heaviside's units in order that my results may be comparable with his. The origin is at the centre of the sphere, and the axes of x and y are respectively parallel to the direction of motion and to the direction of the uniform electric field.

When u/v is very small, the electric force E, *due to the moving sphere*, is the same as if the sphere were at rest, and is therefore derivable from a potential function. Since there is no electric force inside the sphere, the induced distribution on the sphere produces the potential Fy at internal points, and hence produces the potential $\mathrm{F}a^3y/r^3$ at external points. Thus at internal points the components of E are

$$\mathrm{E}_1=0, \quad \mathrm{E}_2=-\mathrm{F}, \quad \mathrm{E}_3=0,$$

while at external points they are

$$\mathrm{E}_1=\frac{\mathrm{Q}x}{4\pi cr^3},$$

$$\mathrm{E}_2=\frac{\mathrm{Q}y}{4\pi cr^3}+\mathrm{F}a^3\left(\frac{3y^2}{r^5}-\frac{1}{r^3}\right),$$

$$\mathrm{E}_3=\frac{\mathrm{Q}z}{4\pi cr^3}+\mathrm{F}a^3.\frac{3yz}{r^5}.$$

Finite Conductivity, Final Stage.—In this case the magnetic force is entirely due to the motion of the charge on the sphere, and we have

$$\mathrm{H}_1=0, \quad \mathrm{H}_2=-uc\mathrm{E}_3, \quad \mathrm{H}_3=uc\mathrm{E}_2,$$

and thus $\mathrm{H}^2=u^2c^2(\mathrm{E}_2{}^2+\mathrm{E}_3{}^2)$.

If, now, we write

$$x=r\cos\theta, \quad y=r\cos\phi\sin\theta, \quad z=r\sin\phi\sin\theta,$$

we find that for internal points $\mathrm{H}^2=u^2c^2\mathrm{F}^2$, and that for external points

$$\mathrm{H}^2=u^2c^2\left[\frac{\mathrm{Q}^2\sin^2\theta}{16\pi^2c^2r^4}+\frac{\mathrm{QF}a^3}{2\pi cr^5}\cos\phi\sin\theta\,(3\sin^2\theta-1)\right.$$
$$\left.+\frac{\mathrm{F}^2a^6}{r^6}\left(1-6\cos^2\phi\sin^2\theta+9\cos^2\phi\sin^4\theta\right)\right].$$

The magnetic energy is $\frac{1}{2}\mu\mathrm{H}^2$ per unit volume, and thus the total magnetic energy is

$$\mathrm{T}=\tfrac{1}{2}\mu u^2c^2\mathrm{F}^2.\tfrac{4}{3}\pi a^3+\tfrac{1}{2}\mu\int\int\int\mathrm{H}^2r^2\sin\theta\,dr\,d\theta\,d\phi,$$

where r ranges from a to infinity, ϕ from 0 to 2π, and θ from 0 to π. On effecting the integration, we find

$$\mathrm{T}=\tfrac{1}{2}u^2[\mu\mathrm{Q}^2/6\pi a+16\pi\mu c^2\mathrm{F}^2a^3/5]=\tfrac{1}{2}mu^2,$$

where m is the magnetic inertia.

For motion parallel to F instead of right angles to it, Dr. Heaviside finds (NATURE, April 19)

$$\mathrm{T}=\tfrac{1}{2}u^2[\mu\mathrm{Q}^2/6\pi a+8\pi\mu c^2\mathrm{F}^2a^3/5].$$

When the quantities are measured in ordinary units the results become

$$\mathrm{T}=\tfrac{1}{2}u^2[2\mu\mathrm{Q}^2/3a+4\mu c^2\mathrm{F}^2a^3/5] \qquad \text{(Searle)}$$

and

$$\mathrm{T}=\tfrac{1}{2}u^2[2\mu\mathrm{Q}^2/3a+2\mu c^2\mathrm{F}^2a^3/5], \qquad \text{(Heaviside)}$$

where, if we use C.G.S. electromagnetic units, we have $\mu=1$ and $c=(3\times10^{10})^{-2}$.

Infinite Conductivity.—In this case a system of currents flows round the sphere, on its surface, in planes normal to the axis of z, the distribution being such as to give rise to a magnetic potential $-uc\mathrm{F}z$ at internal points. The magnetic force due to these conduction currents then neutralises, at internal points, the magnetic force $-uc\mathrm{F}$ due to the moving charges. The external magnetic force *due to the conduction currents* will satisfy Laplace's equation for very slow speeds, and must, therefore, be expressible in zonal harmonics, while, for all speeds, the magnetic force normal to the sphere must be continuous. If $z/r=\cos\psi$, the normal force at points just inside the sphere is $uc\mathrm{F}\cos\psi$. The conditions are satisfied by the external potential

$$\Omega=uc\mathrm{F}a^3\cos\psi/2r^2=uc\mathrm{F}a^3z/2r^3,$$

for this is a zonal harmonic, and gives rise to the normal force $uc\mathrm{F}\cos\psi$ at the surface.

Thus, at external points,

$$\mathrm{H}_1=-d\Omega/dx, \quad \mathrm{H}_2=-d\Omega/dy-uc\mathrm{E}_3, \quad \mathrm{H}_3=-d\Omega/dz+uc\mathrm{E}_2,$$

where E_1, E_2, E_3 have the values already given. We thus find

$$\mathrm{H}_1=\frac{3uc\mathrm{F}a^3xz}{2r^5},$$

$$\mathrm{H}_2=-\frac{uc\mathrm{Q}z}{4\pi cr^3}-\frac{3uc\mathrm{F}a^3yz}{2r^5},$$

$$\mathrm{H}_3=\frac{uc\mathrm{Q}y}{4\pi cr^3}+uc\mathrm{F}a^3\left[\frac{6y^2+3z^2}{2r^5}-\frac{3}{2r^3}\right].$$

It will be found that $x\mathrm{H}_1+y\mathrm{H}_2+z\mathrm{H}_3=0$ for all values of r, and thus the magnetic force is tangential to the sphere, a condition pointed out to me by Dr. Heaviside.

Hence we find

$$\mathrm{H}^2=u^2c^2\left[\frac{\mathrm{Q}^2\sin^2\theta}{16\pi^2c^2r^4}+\frac{3\mathrm{QF}a^3}{4\pi cr^5}\cos\phi\sin\theta(2\sin^2\theta-1)\right.$$
$$\left.+\frac{\mathrm{F}^2a^6}{4r^6}\left\{36\sin^4\theta\cos^2\phi-9\sin^2\theta(4\cos^2\phi+\sin^2\phi)+9\right\}\right].$$

Remembering that H=0 at points inside the sphere, we find, on integration through the external space, that the magnetic energy is

$$\mathrm{T}=\tfrac{1}{2}u^2[\mu\mathrm{Q}^2/6\pi a+6\pi\mu c^2\mathrm{F}^2a^3/5].$$

When the quantities are expressed in ordinary units the result becomes

$$\mathrm{T}=\tfrac{1}{2}u^2[2\mu\mathrm{Q}^2/3a+3\mu c^2\mathrm{F}^2a^3/10].$$

If an electron be a conducting sphere of radius 10^{-13} cm. with a charge of 10^{-20} electromagnetic units, an electric force of a billion volts, or 10^{20} C.G.S. units, per centimetre, would not change its magnetic inertia by so much as one part in ten billions, and the results are of no consequence in experiments on the electrostatic deflection of kathode rays; but it is possible that there are other cases where it would be necessary to take the change of magnetic inertia into account.

When u becomes comparable with v, the analysis becomes more complicated, but does not present any difficulty, at least in the final stage, with finite conductivity, provided a Heaviside ellipsoid be substituted for a sphere.

In conclusion, I desire to acknowledge the help I have received from Dr. Heaviside's suggestions, and to thank Mr. Norman R. Campbell for verifying the formulæ.

G. F. C. SEARLE.

The Date of Easter.

THAT the formula of Gauss for finding the date of Easter fails in certain cases, of which the year 1954 is one, was pointed out by Gauss in his original paper in the *Monatliche Correspondenz* (vol. ii., p. 129), where he shows that there are the following two exceptions to the formula in the Gregorian calendar:—

(1) When the formula gives April 26, Easter falls on April 19.

(2) When the formula gives $d=28$, $e=6$, while $11\mathrm{M}+11$ divided by 30 gives a remainder smaller than 19, then